MB Relay

User Manual

Revision 1a
23rd March 2010

NewElec Pretoria (Pty) Ltd
Head Office: Cnr. 298 Soutter street & Maltzan street
Pretoria West
South-Africa
0182

GPS: 25°45'12"S 28°09'46"E

http://www.newelec.co.za

This user manual is a preliminary document.
NewElec Pretoria (Pty) Ltd reserves the right to change
and to add features towards the final release of the product.

CONTENT

		Page
1.	ABSTRACT	3
2.	SPECIFICATIONS	4
3.	DEFINITIONS AND TERMINOLOGY	11
4.	FUNCTIONAL DESCRIPTION	13
5.	INSTALLATION INSTRUCTIONS	16
5.1	Front-end requirements	
5.2	Setting up procedure	
6.	DIAGRAMS:	
6.1.1	Picture of the relay	
6.1.2	Physical layout of the relay	
6.2	Block diagram of the relay	
6.3	Front-End Setup Screens	
6.3.1	Settings Screen	
6.3.2	Control Logic Screen	
6.3.3	Starter Logic Screen	
6.3.4	Statistics and Network Screen	
6.3.5	Real Time Clock Screen	
6.4	Front-End Assistance Screens	
6.4.1	Test Screen (Manual)	
6.4.2	Test Screen (Automatic)	
6.4.3	Spectrum Analyzer Screen (square wave)	
6.4.4	Spectrum Analyzer Screen (sine wave)	
6.4.5	Actual Screen	
6.4.6	Calculator Screen	
6.4.7	Fault Screen	
6.4.8	Event Screen	
6.4.9	Recorder Screen	
6.5	Thermal Curves of the Relay	
7.	ACCESSORIES	32
7.1	FLED	
7.2	IrDA interface	
7.3	MMI	
7.4	RDU	

1. Abstract

The MB Relay is an ISO 9001:2000 compliant, local designed and manufactured three phase motor protection relay. It is a micro-controller based precision instrument with protection and advanced control features. The relay is designed to cater for the low voltage motor protection market and is available in different current models. The current transformers and the core balance current transformer are internal.

The relay is fully configurable with the aid of front-end software. Event records can also be uploaded with for further analysis. All the settings are password protected. The relay has an on board database where time and date stamped records are kept. Two types of records are kept namely fault records (45 last faults) and event records (1500 events). In the case of event records, the user has limited access rights (read only). The front-end also has a data recorder and a spectrum analyzer which could be used to analyze motor performance and supplied power quality respectively. The spectrum analyzer can detect harmonics up to the 9th harmonic on any of the three phase currents.

The relay detects earth leakage currents with the aid of the external core balance current-transformer and is configurable to operate in inverse definite minimum time (IDMT) or instantaneous definite time (IDT) mode.

A unique feature is added to the relay in the form of simulation. This function could be used for personnel training or relay functionality testing.

2. Specifications

2.1 Measurements

2.1.1 Current

- Three phase current
- Range: 5 Amp to 250 Amps
- Models: 5, 10, 50, 100, and 250.
- Sensitivity range adjustment (MLC): 10% to 100% of full load current
- Dynamic range: 0% to 1000%
- Resolution: 500 steps (2% per step)

2.1.2 Voltage

- Range: 110V, 400V, 525V, 550V, 680V, 950V, 1050V, 3k3V, 6k6V and 11kV

(from 1k1V upwards a step down transformer is used to step the voltage down to 110V).

- Range selection: Manual

2.1.2 Frequency

- Range: 30Hz to 100Hz
- Selectable during calibration: 50Hz or 60Hz (factory setting)

2.1.4 Power Factor

- Range: 0 to 100% (leading / lagging)

2.1.5 Power Dissipation

- Type: Apparent power (kVA) and Real power (kWatt);
- Derived from line voltage, phase current and power factor (where applicable)

2.1.6 Earth Leakage

- Range: 30mA to 3 Amps
- Trip time delay: Inverse Definite Minimum Time (IDMT) or Instantaneous Definite Time (IDT)

2.1.7 Real Time Clock

- 24 hour clock (Year, month, date, hours and minutes)
- Battery backup (5 days with 1 Farad super capacitor)
- Time and date stamping (Fault and event records)

2.1.8 Breaker Fault Clearance Time

- Measurement range: 10 ms to 1000ms
- Resolution: 10ms steps.

2.1.9 Insulation Resistance

- Measurement range: 1 to 199 kOhm

- Resolution: 1 kOhm steps.

2.1 Protection Features

(All resets are subjected to sufficient thermal capacity gain)

2.2.1 Over Current (Overload) Detection

- Curve class settings: 3 seconds to 40 seconds
- IEC 60255-8 specification
- Motor full load setting (MLC): 10% to 100%
- Reset: Manual or three automatic resets per hour (when selected)
- Reset threshold setting: Fixed at 70% thermal capacity or dynamic threshold adjustment determined over 10 last restarts.

2.2.2 Undercurrent (Minimum load) Detection

- Trip level adjustment: 10% to 100%
- Selection: Current level or power factor %
- Trip delay time: 1 to 10 seconds
- Start-up delay: 1 to 200 seconds (To facilitate pump priming)
- Reset time: Manual or 10 seconds to 6 hours (9 steps)
- Feature selectable

2.2.3 Unbalance Phase Currents Detection

- Trip level adjustment: 0 to 50%
- Trip delay time: 1 to 10 seconds
- Reset: Manual
- Feature selectable

2.2.4 Single Phasing (Phase lost) Detection

- Trip delay time: 1 second fixed
- Feature selectable
- Reset: Manual

2.2.5 Run-Stall Detection

- Stall current trip level adjustment: 110% to 300%
- Stall trip delay time: 0 to 120 seconds adjustable
- Feature selectable
- Reset: Manual

2.2.6 Vectorial-Stall Detection

- Trip: Static or decreasing power factor
- Trip delay: 33% of curve class setting.
- Reset: Manual
- Feature selectable

2.2.7 Starts per Hour Control

- Starts setting: 1 to 60 starts adjustable
- Consecutive starts: 1 to 3 starts per interval adjustable
- Reset: Automatic
- Feature selectable

2.2.8 Short Circuit Detection

- Articulated detection: If (I_{LOAD} > 950% and Power factor < 85%) or (I_{LOAD} > 300% and Power factor > 85%)
- Trip delay time: 1 second fixed
- Reset: Manual
- Feature selectable

2.2.9 Voltage Symmetry Detection

- Trip delay time: 10 seconds fixed
- Trip level adjustment: 70% to 99%
- Reset: Manual
- Feature selectable

2.2.10 Over Voltage Detection

- Trip delay time: 10 seconds fixed
- Trip level: Factory settings
- Reset: Manual
- Feature selectable

2.2.11 Under Voltage Detection

- Trip delay time: 10 seconds fixed
- Trip level: Factory settings
- Feature selectable
- Reset: Manual

2.2.12 High or Low Frequency Detection

- Trip delay time: 10 seconds fixed
- Trip level: Factory settings (45Hz to 55Hz)
- Reset: Manual
- Feature selectable

2.2.13 Voltage Phase Rotation

- No trip delay time
- Auto reset once fault is fixed
- Feature selectable (forward, reverse, none)

2.2.14 Insulation Failure Detection

- Detection: Only in static state (motor not running)
- Trip delay time: 1 second fixed
- Trip level: Resistance < 20 kOhm (fixed)

- Reset: Manual
- Feature selectable

2.2.15 Earth Leakage Detection (I_{EL} < 2A)

- Selection between Instantaneous Definite Time or Inverse Definite Minimum Time.
- Instantaneous Definite Time (100 ms ≥ t ≥ 1000 ms), (50 ms steps)
- Inverse Define Minimum Time (t ≥ 130 ms)
- Harmonic filtering (suitable for variable speed drives and soft starters)
- Trip level: Adjustable
- Reset: Manual
- Feature selectable

2.2.16 Earth Fault Detection (I_{EL} ≥2A)

- Harmonic filtering (suitable for variable speed drives and soft starters)
- Trip delay time: 1 second fixed
- Trip level: 2A fixed
- Reset: Manual
- Feature selectable

2.2.17 RTD (PT100) Overtemperature Detection

2.3 Control logic

2.3.1 Table of control outputs which can be mapped to any configurable input.

Input	Input	Input	Input	Input	Input
Zero ('0')	OverVolt_af	MinLoad_tf	RTClock	! LogicFunc_4	PLC_Input_2
One ('1')	UnderVolt_af	OverVolt_tf	! RTClock	LogicFunc_5	PLC_Input_3
InService	VoltSym_af	UnderVolt_tf	Counter_A	! LogicFunc_5	PLC_Input_4
VoltPresentF	HiFreq_af	VoltSym_tf	! Counter_A	LogicFunc_6	PLC_Input_5
OverCrnt_af	LoFreq_af	HiFreq_tf	Counter_B	! LogicFunc_6	PLC_Input_6
ShortCirc_af	IsoLockOut_af	LoFreq_tf	! Counter_B	DigFldInput_1	PLC_Input_7
RunStall_af	OverCrnt_tf	IsoLockOut_tf	LogicFunc_1	DigFldInput_2	PLC_Input_8
I_Unbal_af	ShortCirc_tf	PhaseRot_tf	! LogicFunc_1	DigFldInput_3	StarterOutp_1
I_Unbal_af	RunStall_tf	StartsPerHr_tf	LogicFunc_2	DigFldInput_4	StarterOutp_2
SinglePhs_af	I_Unbal_tf	Timer_A	! LogicFunc_2	DigFldInput_5	StarterOutp_3
EarthFault_af	SinglePhase_tf	! Timer_A	LogicFunc_3	DigFldInput_6	Restart
EarthLeak_af	EarthFault_tf	Timer_B	! LogicFunc_3	DigFldInput_7	FrozenContact
MinLoad_af	EarthLeak_tf	! Timer_B	LogicFunc_4	PLC_Input_1	TripFlag

2.3.2 Timers
- Timer A and Timer B
- Time setting: 0 to 50 minutes
- Start input: Configurable and level triggered (see 2.3.1)
- Reset / Inhibit input: Configurable and level triggered (see 2.3.1)

2.3.3 Real Time Clock (24 Hour)
- Start time: Hours and minutes configurable (see 2.3.1)
- Stop time: Hours and minutes configurable (see 2.3.1)

2.3.4 Counters
- Counter A and Counter B
- Count range: 0 to 250
- Count up input: Configurable and positive edge triggered (see 2.3.1)
- Count down input: Configurable and positive edge triggered (see 2.3.2)
- Reset / Inhibit input: Configurable and level triggered (see 2.3.1)
- Trip level setting: 1 to 250 counts

2.3.5 Logic function blocks
- Amount of function blocks: 6
- Three fully configurable inputs per logic function block (see 2.3.1).
- Sum of product or product of sums operation

2.3.6 Starter Logic
- Starter types:
  - Direct On Line Starter
  - Reversible Direct On Line Starter
  - Star-Delta Starter
  - Reversible Star-Delta Starter
  - Dahlander Starter
  - Reversible Dahlander Starter
  - Soft Starter.
  - Reversible Soft Starter
  - Pulsed Output Direct On Line Starter
- Timers:
  - Star Maximum Timer: 1 to 50sec
  - Pre Start Warning Timer: 1 to 1200 sec (20 min)
  - Execution Timer: 1 to 10 sec (Start executing)
  - Feedback Timer: 50ms to 2000ms (Power dips)
  - Unautherised Current Timer: 50ms to 2000ms
  - Backspin Timer: 1 to 600 sec
  - Transition Timer: 50ms to 5000ms (Change over from high speed to low speed)
- Selectable control sites: Local, remote, automatic (PLC control) and operator pannel

2.3.1 Relays

- Amount of Relays: 4
- Input: Configurable and level triggered (see 2.3.1)
- Slow relay 1 / Fast main trip Relay selectable.
- Single set of potential free switch-over contacts

2.4 Statistical Data Capturing

- Running hours: Adjustable (0 to 65535 hours)
- Startup counter: Adjustable (0 to 65535)
- Trip counter: Adjustable (0 to 65535)
- Apparent power consumption metering (kV.A.h)
- Real power consumption metering (kWatt.h)

2.5 Trip Fault Recording

2.5.1 Database capacity: 45 last faults

2.5.2 Trip fault record content:

- Status: (Actual / simulated)
- Date: Year, month, date
- Time: Hour, minute
- Fault description
- Run hours
- Max trip current
- Minimum trip voltage
- Breaker fault clearance time.

2.6 Event Recording

2.6.1 Database capacity: 1500 last events

2.6.2 Event record content:

- Status: Actual, Simulated, Settings adjust, Power up, Calibration
- Date: Year, month, date
- Alarm flags
- Trip flags
- Run hours
- Max trip current
- Min trip voltage
- Breaker fault clearance time
- Digital field input states

2.7 Physical dimensions

2.7.1 Size of foot print: 45 mm x 110 mm (DIN Rail mount / screw fix mount)

2.7.2 Length: 110 mm
2.7.3 Mass: 400 gram

2.8 Auxiliary power supply

- Voltage requirements: 110 Vac ± 10% or 230 Vac ± 10%
- Power requirements: 2,5 Watt

2.9 Operating environment

- Temperature: 0 – 50° Celsius
- Relative humidity: < 85

2.10 Networking (Communication)

2.10.1 Protocol:
- Profibus
- ModBus
- Canbus

3. Definitions and Terminology

Breaker clearance time	It is the time taken by the breaker to clear the fault by interrupting the supply current to the motor. It can be seen as breaker response time and is useful information for breaker maintenance.
Consecutive starts	The amount of starts allowed during a time interval created by the starts per hour setting. (See also starts per hour)
Core balance current transformer	A current transformer used to detected possible current leakage to earth from one or more of the phases. (Earth leakage detection)
Digital field input	A signal generated by an external switch that could have an effect on the relay operation depending on the logic configuration.
Earth fault	It is leakage current above 2 amps and a severe form of an earth leakage condition. (See also core balance current transformer)
Earth leakage fault	It is leakage current up to 2 amps exceeding a trip level setting. (See also core balance current transformer)
Full load current	Current drawn by the motor at full load operation (90% to 100%)
Fundamental harmonic frequency	50Hz in South Africa and 60Hz elsewhere.
In Service state	Phase current above 10% of full load current
Isolation lockout / Insulation failure	The insulation resistance of the motor is measured while in a static (not in service) condition. If the resistance drops below 20 kOhm the relay will trip and will prevent a start.
Motor full load setting (MLC)	Adjustment of the relay current sensitivity. This is where the current level measurement is adjusted to read just below 100% when the motor operate at full load.
Non volatile memory	It is memory that will maintain data even when power is switched off for long periods. (see also volatile memory)
Over current (Overload)	Current level above 100% of full load current
Phase rotation	Normal phase rotation sequence is red, white and blue. Reverse rotation sequence is blue, white and red.
Power factor	It is die relationship between real power and apparent power Power factor % = ((V x I x CosØ) / (V x I)) x 100% Power factor = CosØ
Run-Stall	The motor went through the normal start procedure and the current level return to normal full level. If the rotor jam and the current rise above the stall setting (110% to 300%) it is recognized as a Run-Stall fault condition.
Running hours	The amount of time the motor was in an in-service state.
Starts per hour	Starts per hour define the time interval in which a restricted amount of starts are allowed. (See also consecutive starts)
Thermal capacity	It is a temperature related quantity expressed in percentage, which also takes in consideration the physical size, mass, construction, type of material used etcetera of the motor. It is normally indicated

	as capacity used unless otherwise stated.
Thermal curve class	It is the thermal curve derived from the unitary (one second) thermal curve. It is also the curve that goes through the points where maximum lock rotor current and maximum lock rotor time of the particular motor is specified.
Total Harmonic Distortion	Two standards are used: $THD = \frac{\sqrt{H_1^2 + H_2^2 + \dots H_n^2}}{H_1} \times 100\ \%$ $THD = \frac{\sqrt{H_1^2 + H_2^2 + \dots H_n^2}}{H_1 + H_2 + \dots H_n} \times 100\ \%$
Undercurrent (Minimum load)	Current level when motor run at no load condition.
Vectorial-Stall Vectorial-Stall continue ….	It is detected during the startup procedure of the motor. A motor normally startup with a bad power factor and gradually improve it as full speed is approached. If no power factor improvement is detected for longer then 33% of the curve class time the motor is tripped to prevent thermal and mechanical damage.
Volatile memory	It is memory that will loose data during a power supply interruption. (see also non volatile memory)

4. Functional Description

The MB Relay is controlled by a micro-controller. The three phase currents, voltages and earth leakage current are detected by current transformers, attenuator circuits and a core balance current transformer respectively. The current and voltage signals are conditioned by appropriate circuits and converted to 0 to 5 volt analogue signals. The analogue signals are digitized to 10 bit resolution.

The micro-controller has non volatile and volatile memory. The non volatile memory contains a boot loader program which is used to upload the operating software program of the relay. The uploading is done from a personal computer or laptop via the USB port. This feature also enables the user to do future software upgrades without factory assistance.

Front-end software is included that runs on MS Windows™. The USB port and infra red link (IrDA) are used as communication ports. The purpose of the front-end is to configure and select the required functionality of a specific application. The setup adjustments required at the installation phase will be discussed in the next chapter dealing with installation instructions.

The relay will monitor the parameters of the motor for the duration of auxiliary power supply. The auxiliary power supply is selectable (110Vac or 230Vac). When a trip condition occurs, the main trip relay will be activated. It will be energized or de-energized (non fail save or fail save respectively) depending on what mode of operation was selected. A time and date stamped trip record is also generated and saved in non volatile memory for later retrieval. Memory space for 60 trip records is allocated. The layout of the trip record is discussed in chapter 2 that deals with specifications.

Event records are also time and date stamped. It is more comprehensive and saved in non volatile memory. Only read access is given to the user. This information can be used for insurance claims and liability cases. The layout of the event record is discussed in chapter 2 (specifications).

Six fault indication light emitting diodes (red) are placed on the front panel. The green light emitting diode will come on only if the relay is in a healthy state. A healthy state signifies that the motor could be static or in operation within it’s save operating parameters. The fault indications are displayed on the front panel as follows:

Name of Fault	**Indication LED used**	**Display mode**
Over current	Overload	Solid on
Short circuit	Overload	Solid on
Minimum load	Min Load	Solid on
Phase Rotation	Phase Rotation	Solid on
Unbalance Phase Currents	Unbalance	Solid on
Single Phasing	Unbalance	Solid on

Insulation Failure	Insulation failure	Solid on
Run-Stall	Overload	Solid on
Vectorial-Stall	Overload	Solid on
Earth leakage	Earth leakage	Solid on
Earth fault	Earth leakage	Solid on
Over voltage	Phase rotation	3 sec on, 1 sec off
Under voltage	Phase rotation	1 sec on, 3 sec off
Voltage symmetry	Phase rotation	1 sec on, 1 sec off
Starts per hour	Overload & Healthy	Both 1 sec on, 1 sec off
High frequency	Unbalance	3 sec on, 1 sec off
Low frequency	Unbalance	1 sec on, 3 sec off

The reset button is used to acknowledge and reset trip faults. A reset will only take affect if sufficient thermal capacity is regained during the cooling period and no phase current flows. If the reset button is pressed during the cooling cycle the Overload LED will start flashing (1 second on, 1 second off) to signify cooling. Once the required thermal capacity level is reached, the relay will reset.

The real time clock is running from a super capacitor which is continuously charged by the auxiliary power supply. The real time clock should be able to continue running for another 5 days in the event of auxiliary supply failure. The real time clock provides time and date for record keeping (fault and event records) and also participates in the control functions.

The protection unit (NewCode MK-1 relay) is equipped with four electromechanical relays (Relay 1, 2, 3 and 4) and seven opto-isolated digital field inputs (Digital Field Inputs 1 to 7). When Relay 1 is configured as the main trip relay it has a dedicated protection function. Relay 2, 3 and 4 are general purpose relays. The relays are configurable and available to participate in any of the control functions. The control logic is realized with the aid of six logic function blocks. Each of these blocks has three configurable inputs. A configurable input can typically be connected to any one of seventy three different signals (see specifications).

Starter functions are added to the control logic and three types are available to choose from namely Direct On Line (DOL), Star-Delta and Forward / Reverse. Three different start control localities are also selectable namely local, remote and automatic (PLC control) to start the motor from. These start control sites are static or dynamically selectable.

The protection unit has an internal interchangeable communication module. Three different protocols are available and to choose from namely Modbus, Profibus and CANbus.

5. Installation Instructions

5.1 Front-end requirements

A Pentium personal computer or laptop is required to setup the NewCode MK-1 relay. The computer must be equipped with USB ports. The operating system software requirement is MS Windows 2000, MS Windows XP or later versions. The front-end software is free of charge but remains the property of NewElec Pretoria (Pty) Ltd. It is available from NewElec's website and also supplied with the purchase of new relays.

5.2 Setting up the relay

Once the wiring is being done and checked by qualified personnel, the relay is ready to be configured. The four most important front-end screens are the settings (diagram 6.4), control logic, starter and statistics screens. These four screens enable the user to adjust parameters, select protection features, determine control strategy, select a starter configuration and setup the communications network. The control and starter screens are linked together when settings are saved or retrieved from disk.

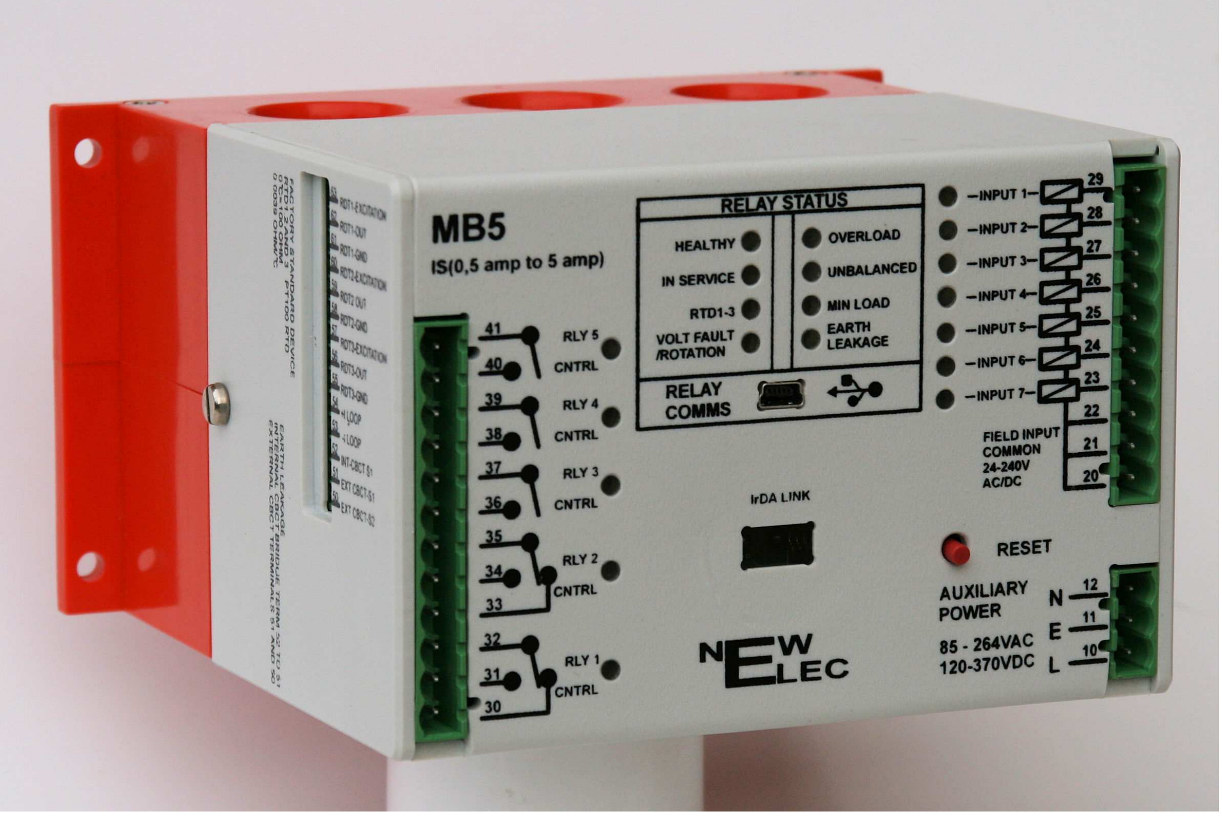
When setting changes were made it has to be transmitted to the relay to become effective. Changes on the control logic and starter screens can only be made when off line is selected. When on line is selected again, the settings are transmitted to the relay. Relays are shipped to the user with a set of default settings and may be appropriate in some cases.

To determine the full load current setting (MLC), the motor has to be started and allowed to run at full load capacity. Press the reset button and use the front-end settings screen to adjust the MLC till the overload indication just switches off. Release now the reset button. The front-end can be used to confirm that the load current level indicated is between 90% and 99%. (Hint: Use the calculator of the front-end to confirm the setting). The minimum load setting adjustment (motor run with no load) is done in a similar way with the aid if the reset button, minimum load setting.

The real time clock should be checked and adjusted to the correct time setting. The fault history can also be erased to start afresh.

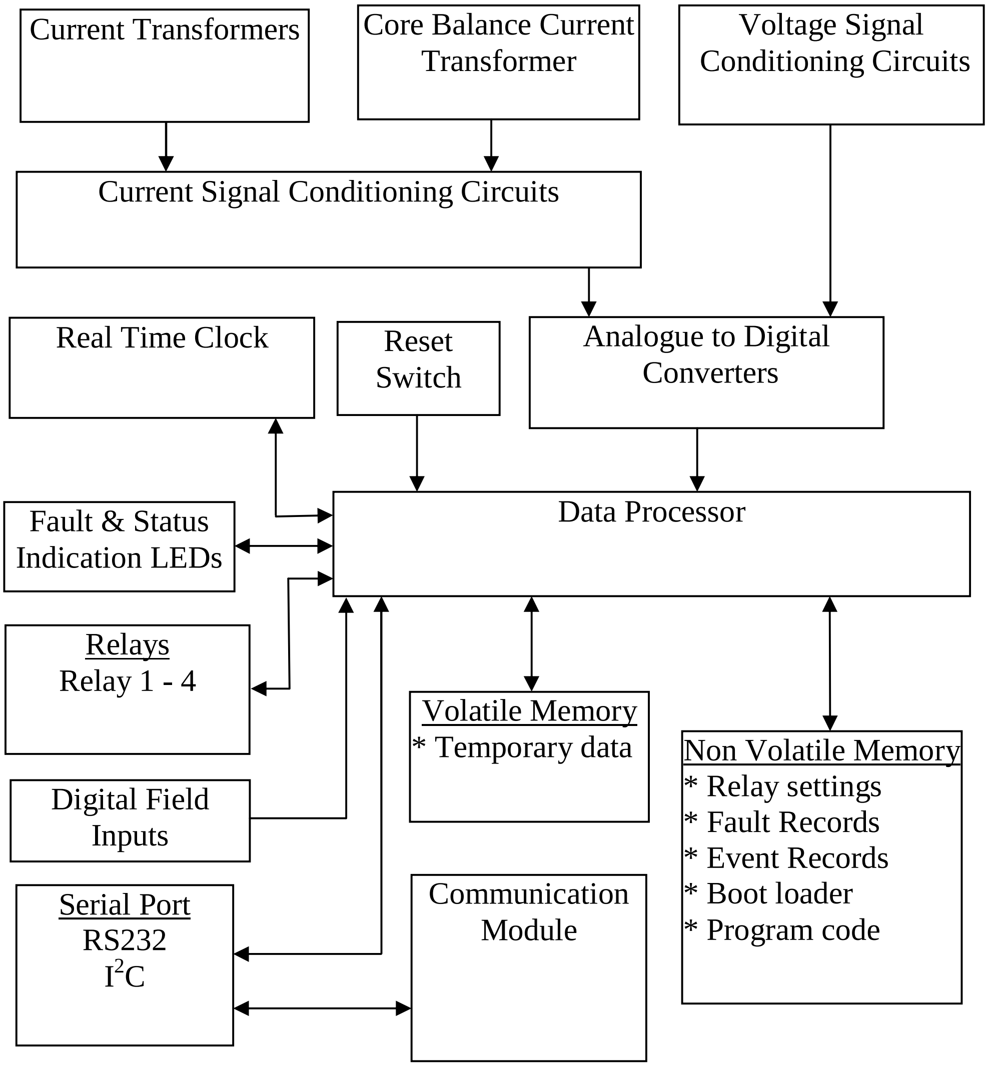
6. Diagrams

6.1.1 Picture of the Relay



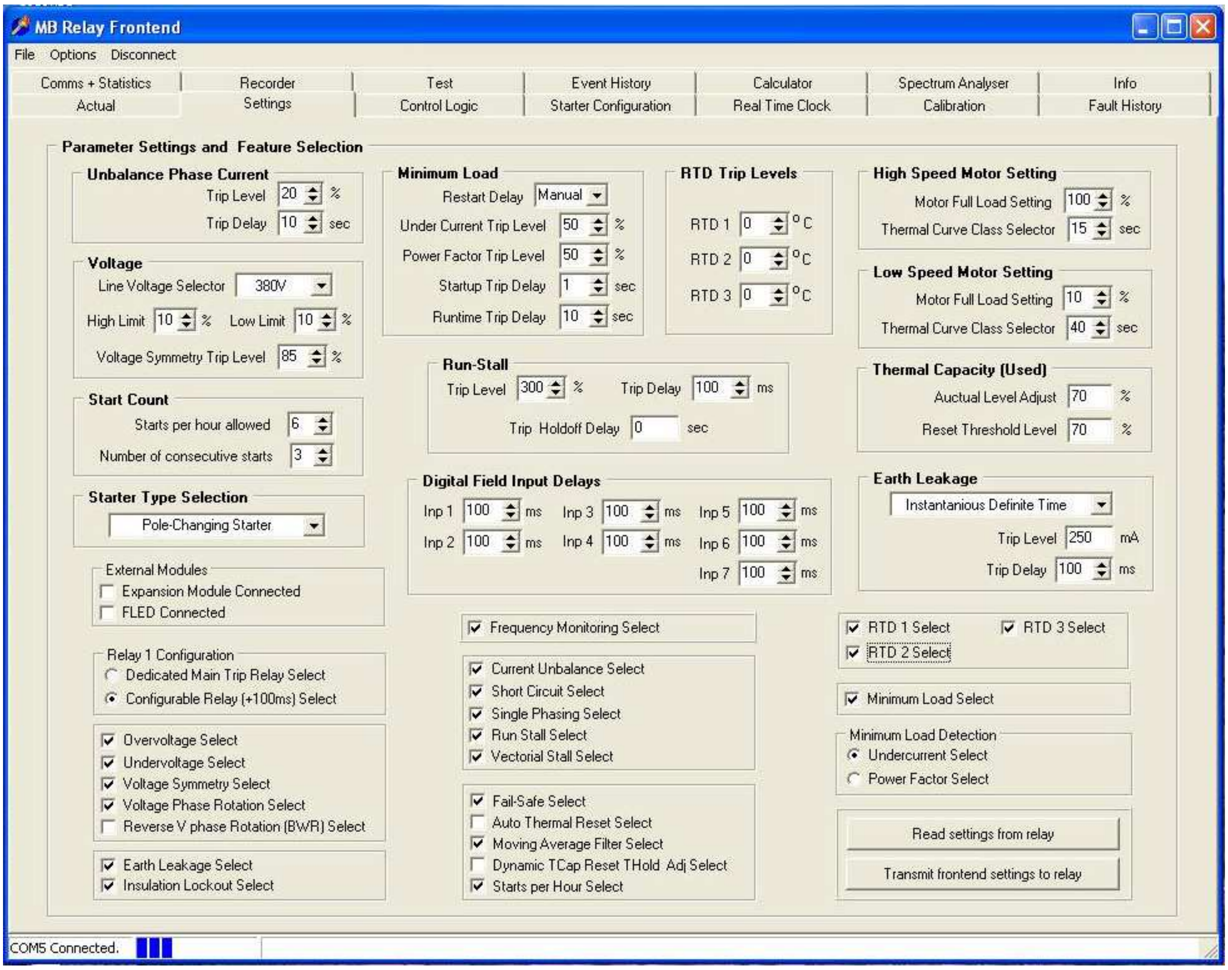
6.1.2 Physical Layout of the Relay (side panels)

6.2 Block Diagram of the Relay

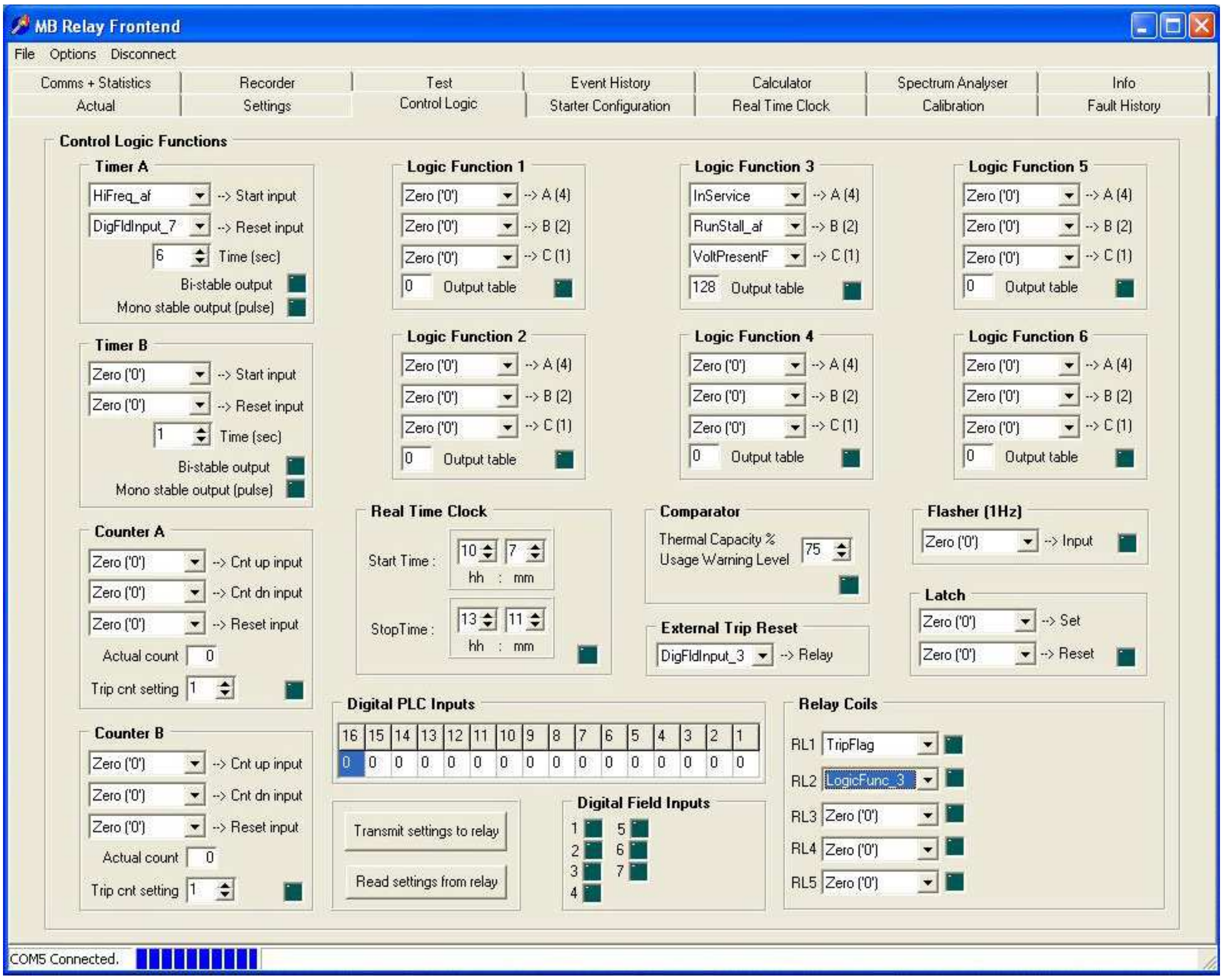


6.3 Front-End Setup Screens

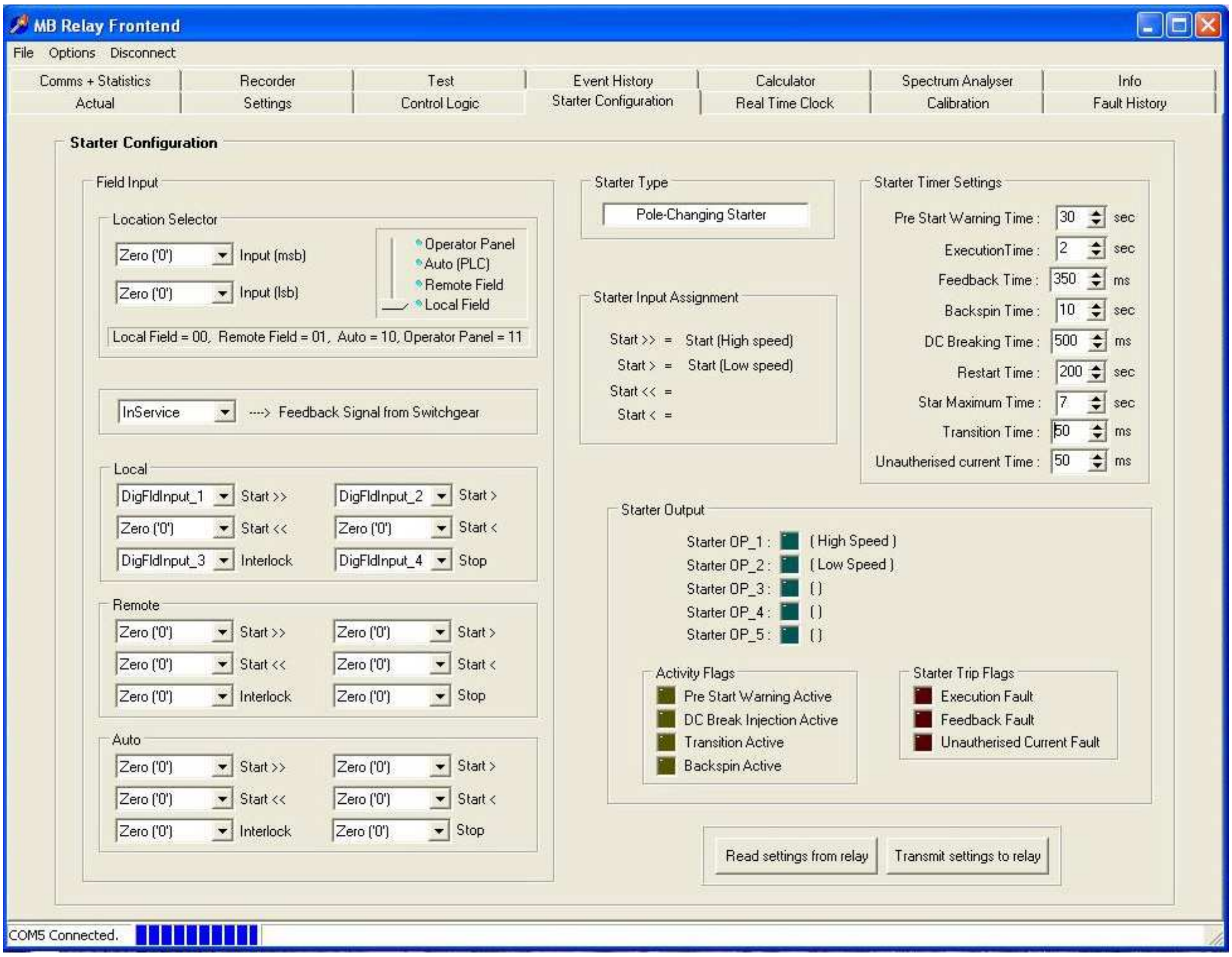
6.3.1 Settings screen



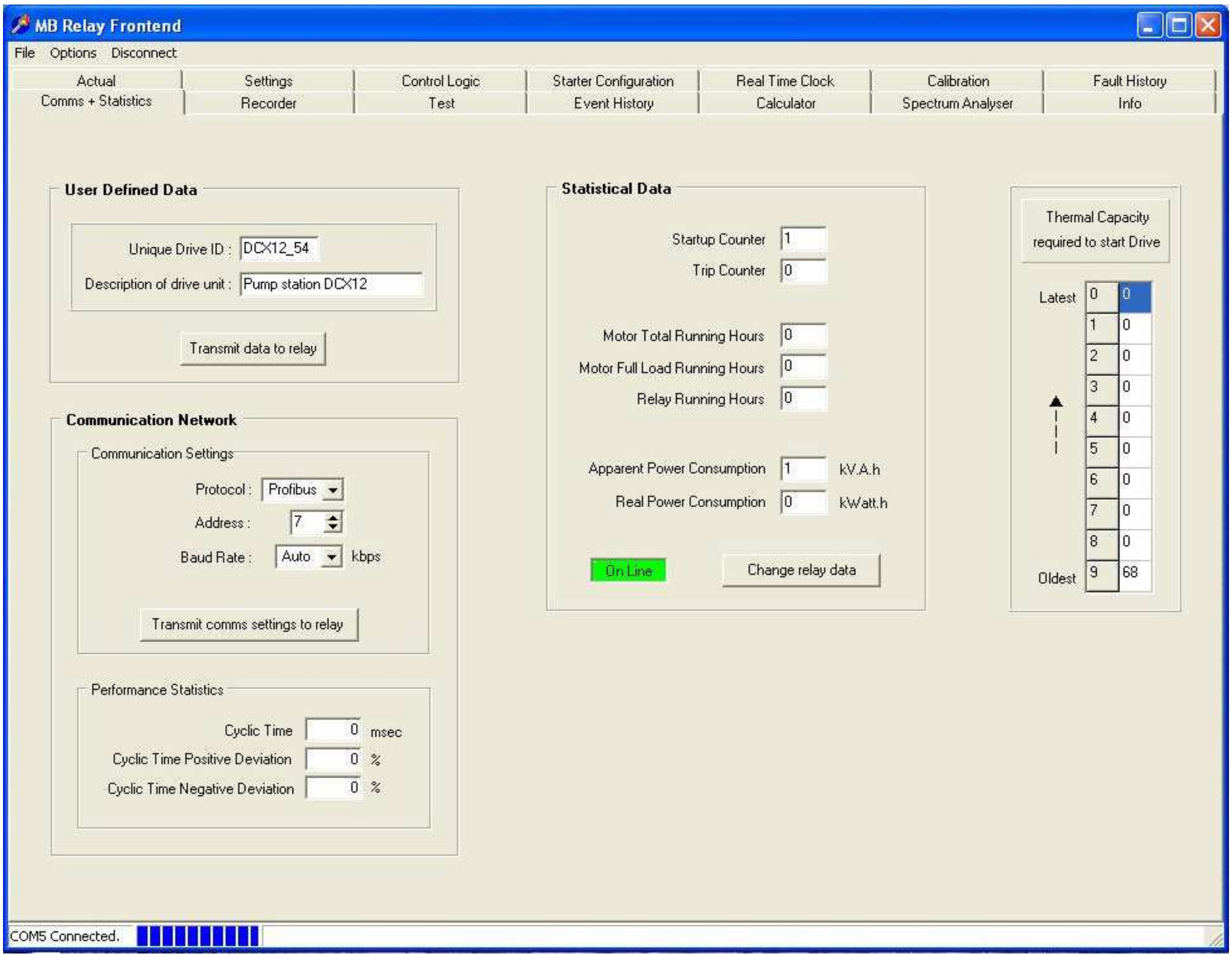
6.3.2 Control Logic Screen



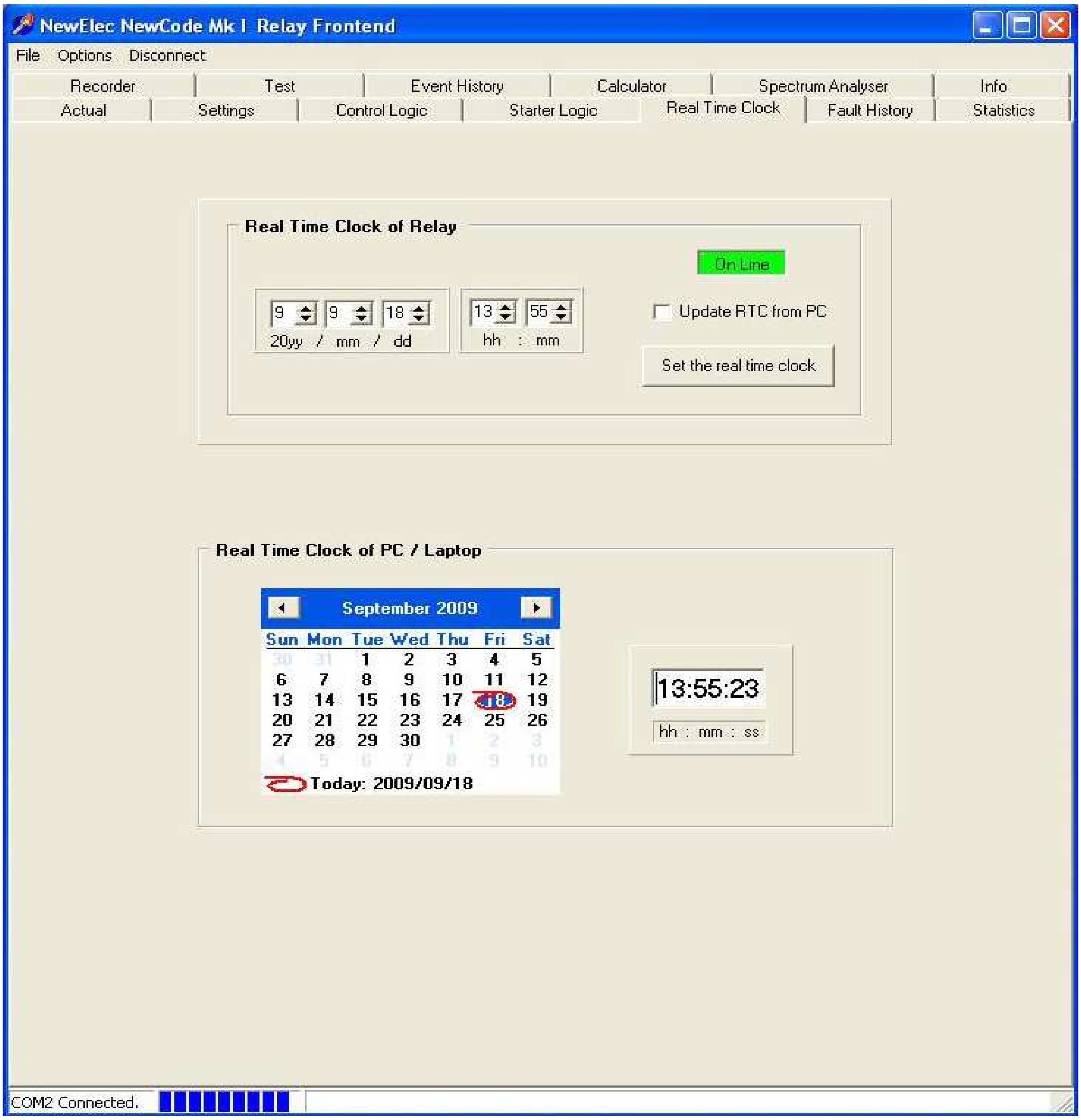
6.3.3 Starter Logic Screen



6.3.4 Statistics Screen

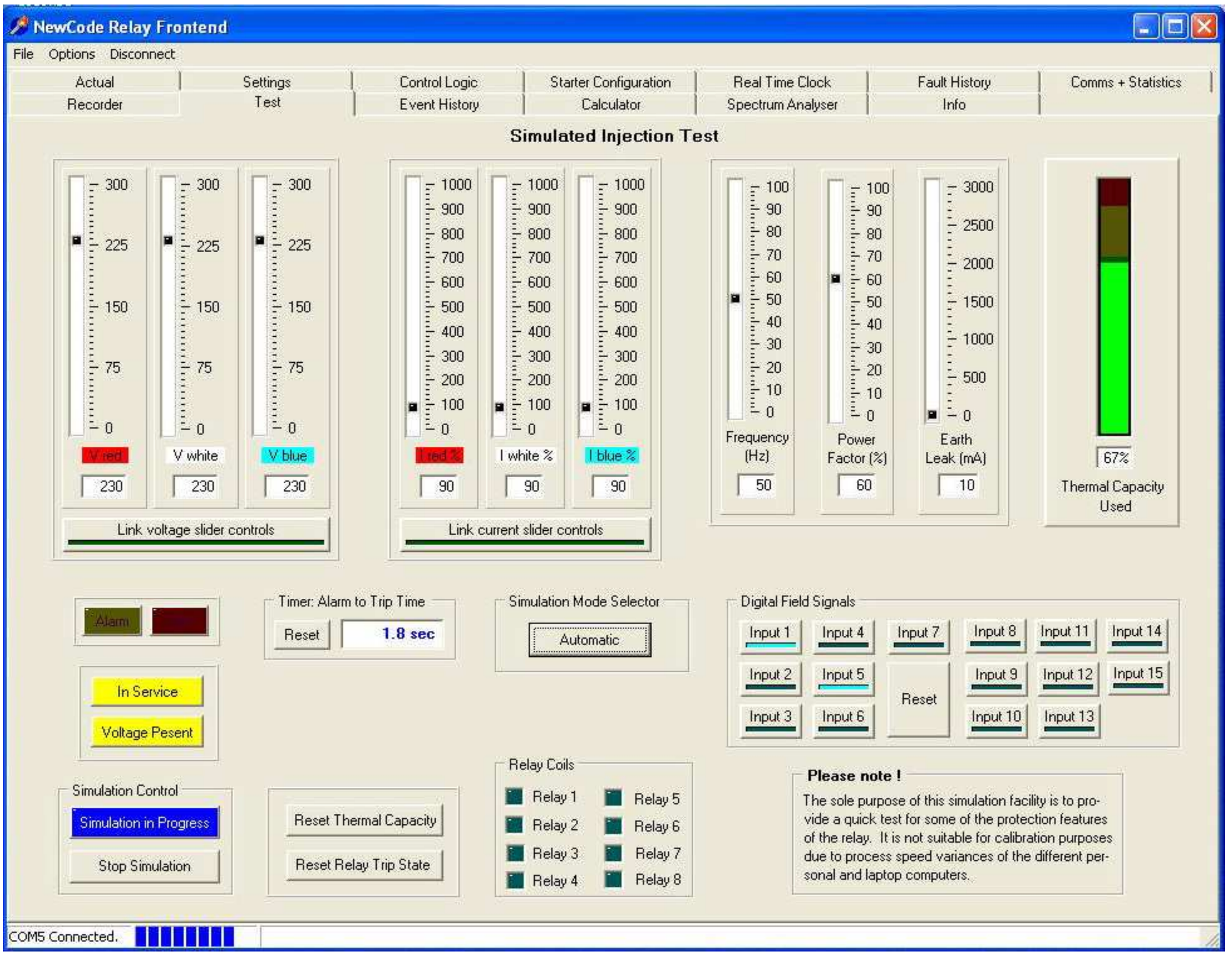


6.3.5 Real Time Clock Screen

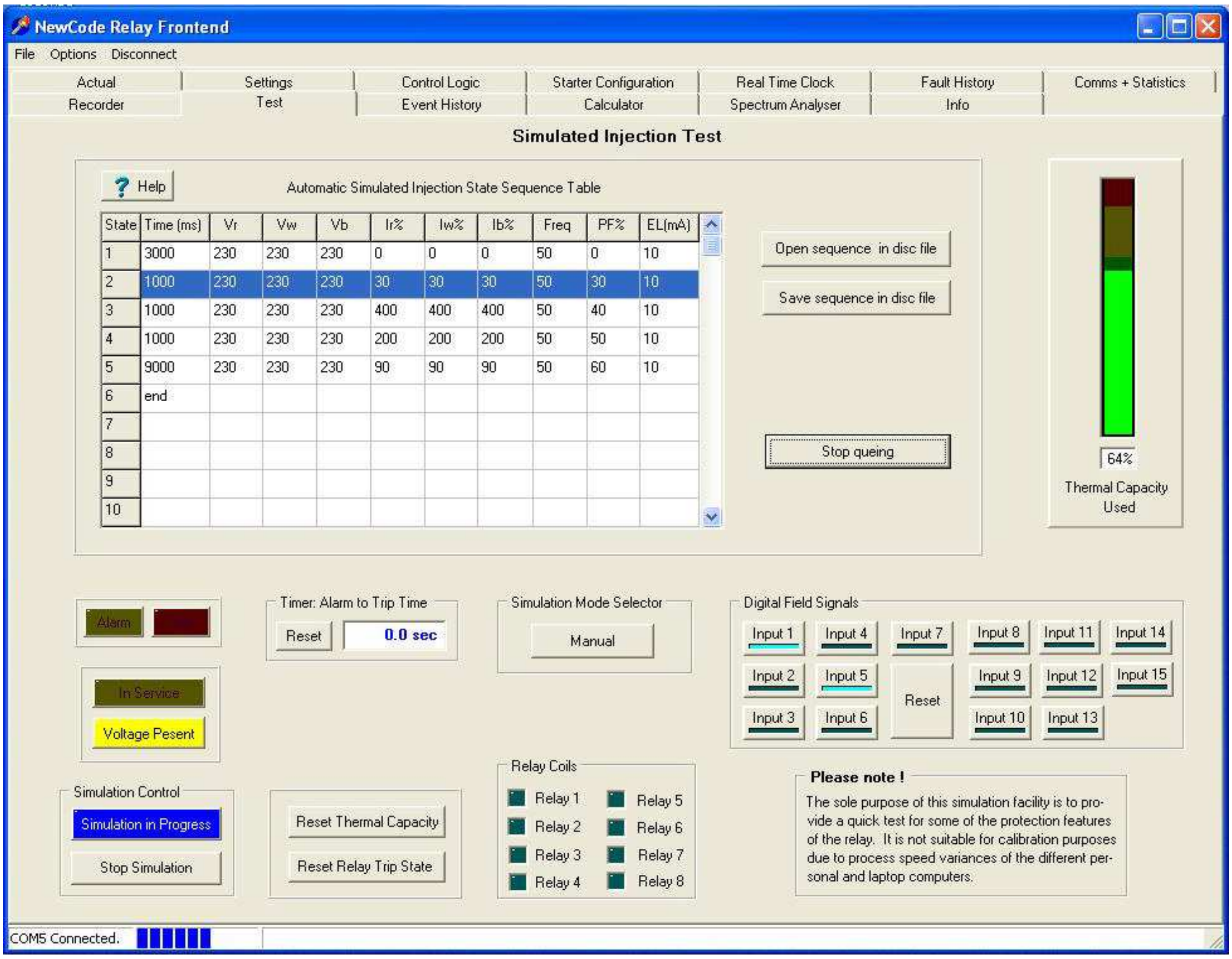


6.4 Front-End Assistance Screens

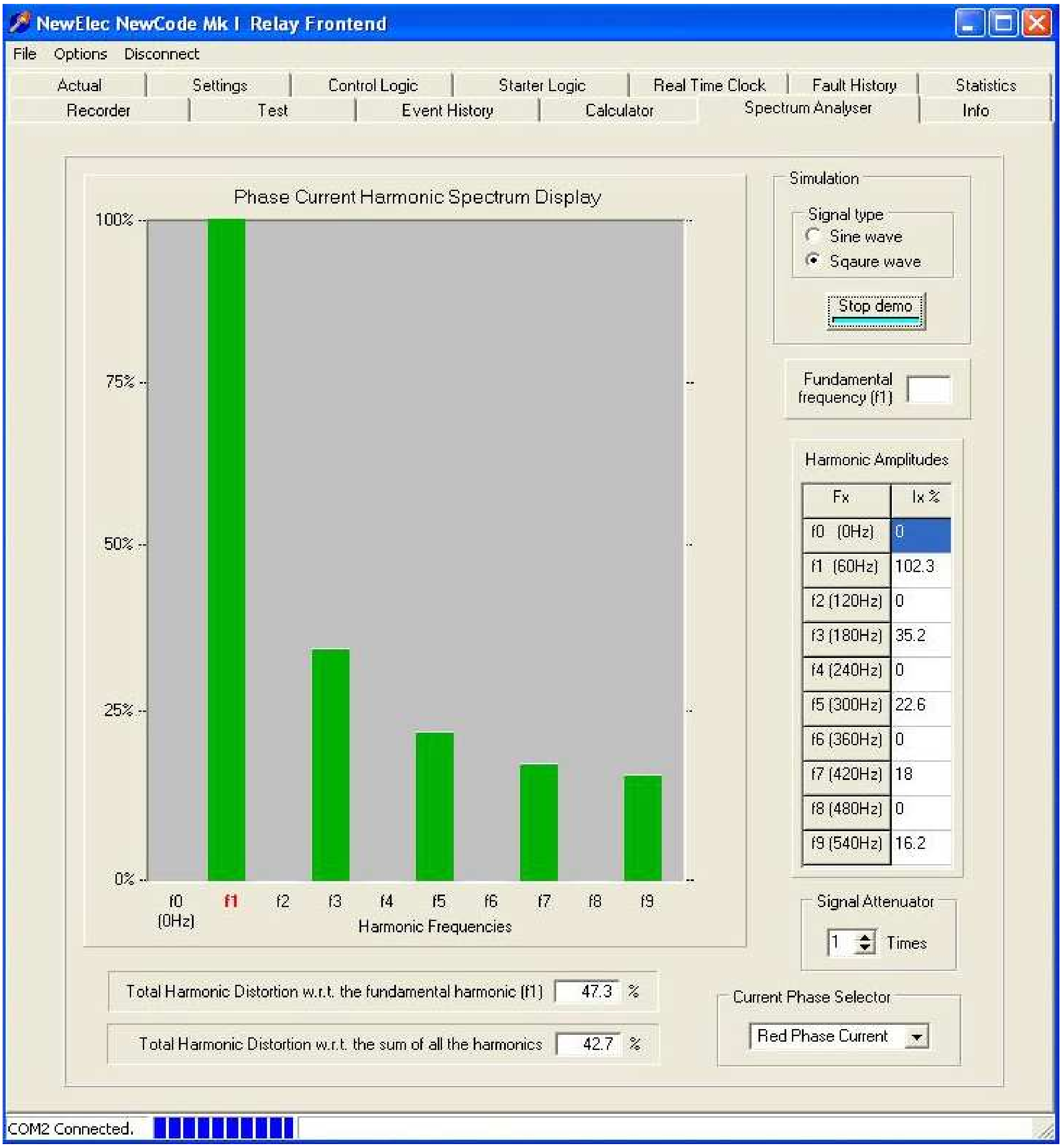
6.4.1 Test Screen (Manual)



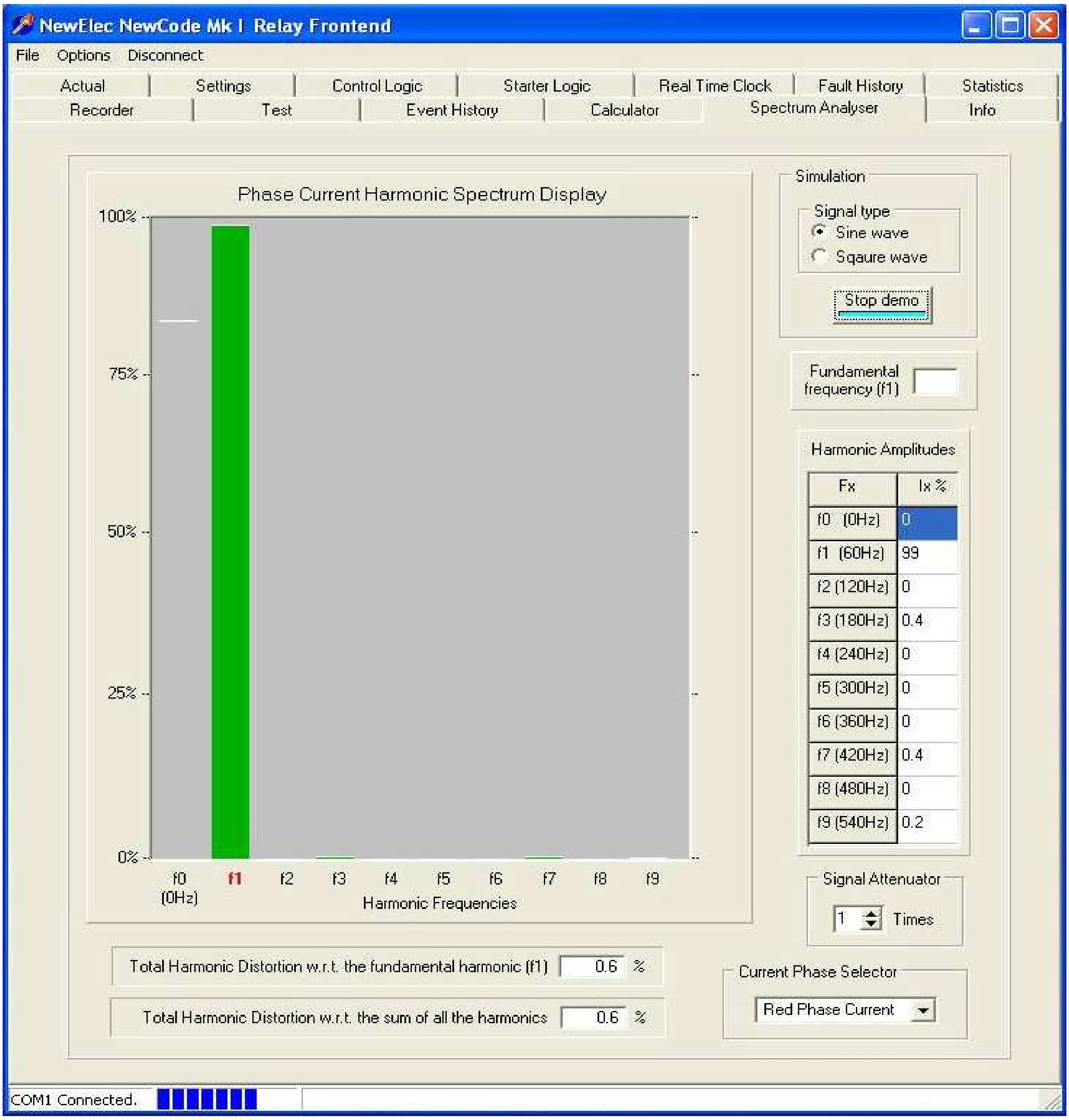
6.4.2 Test Screen (Automatic)



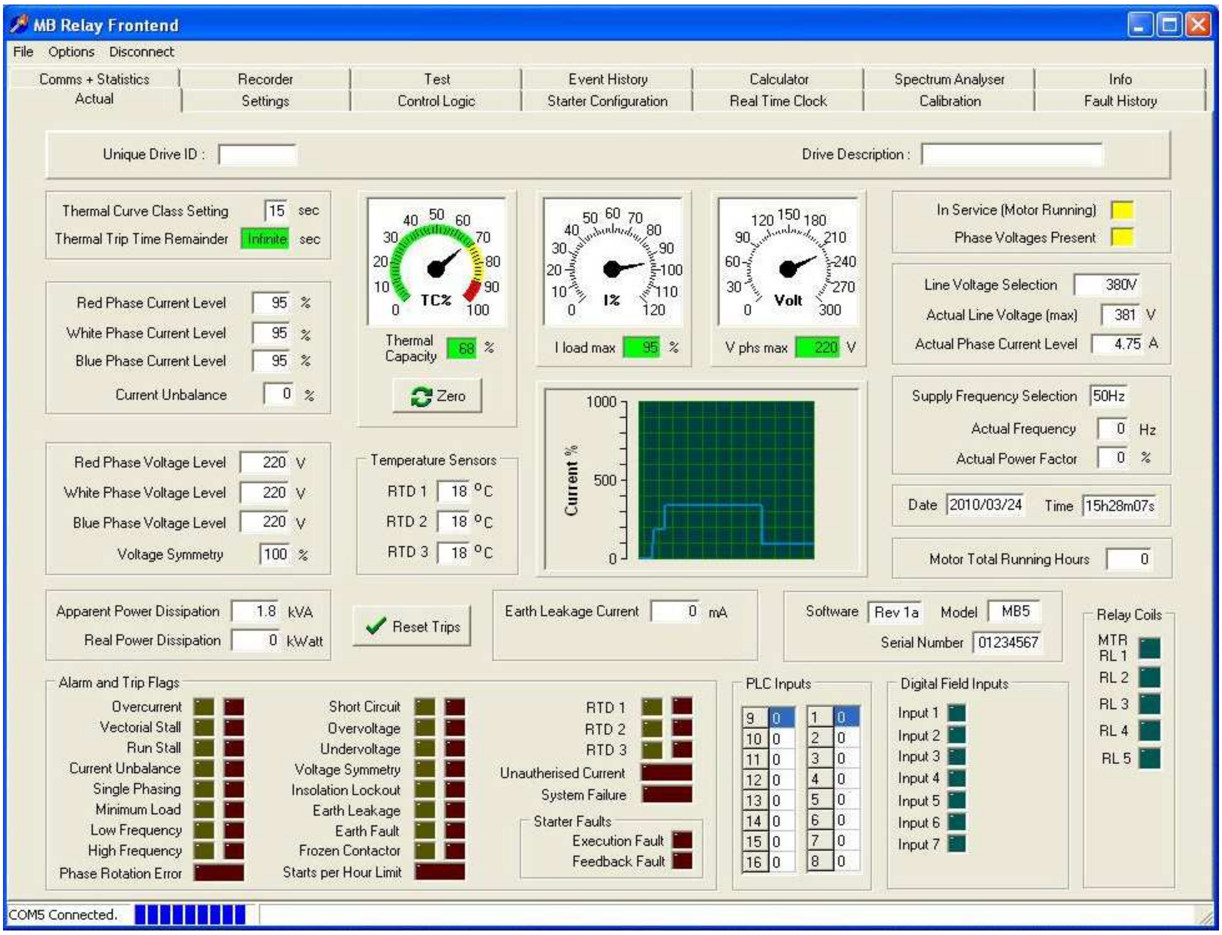
6.4.3 Spectrum Analyzer Screen (1)



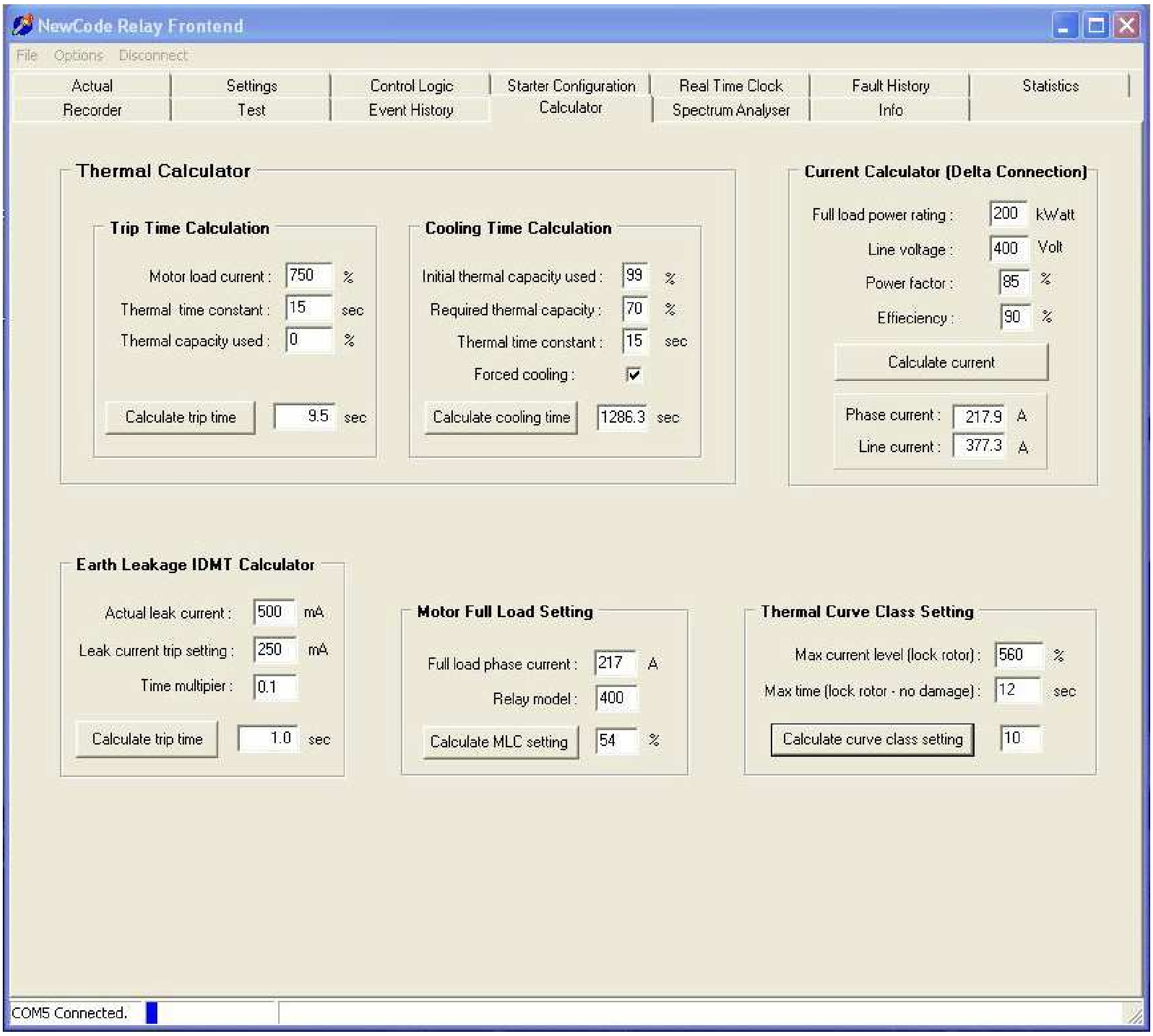
6.4.4 Spectrum Analyser Screen (2)



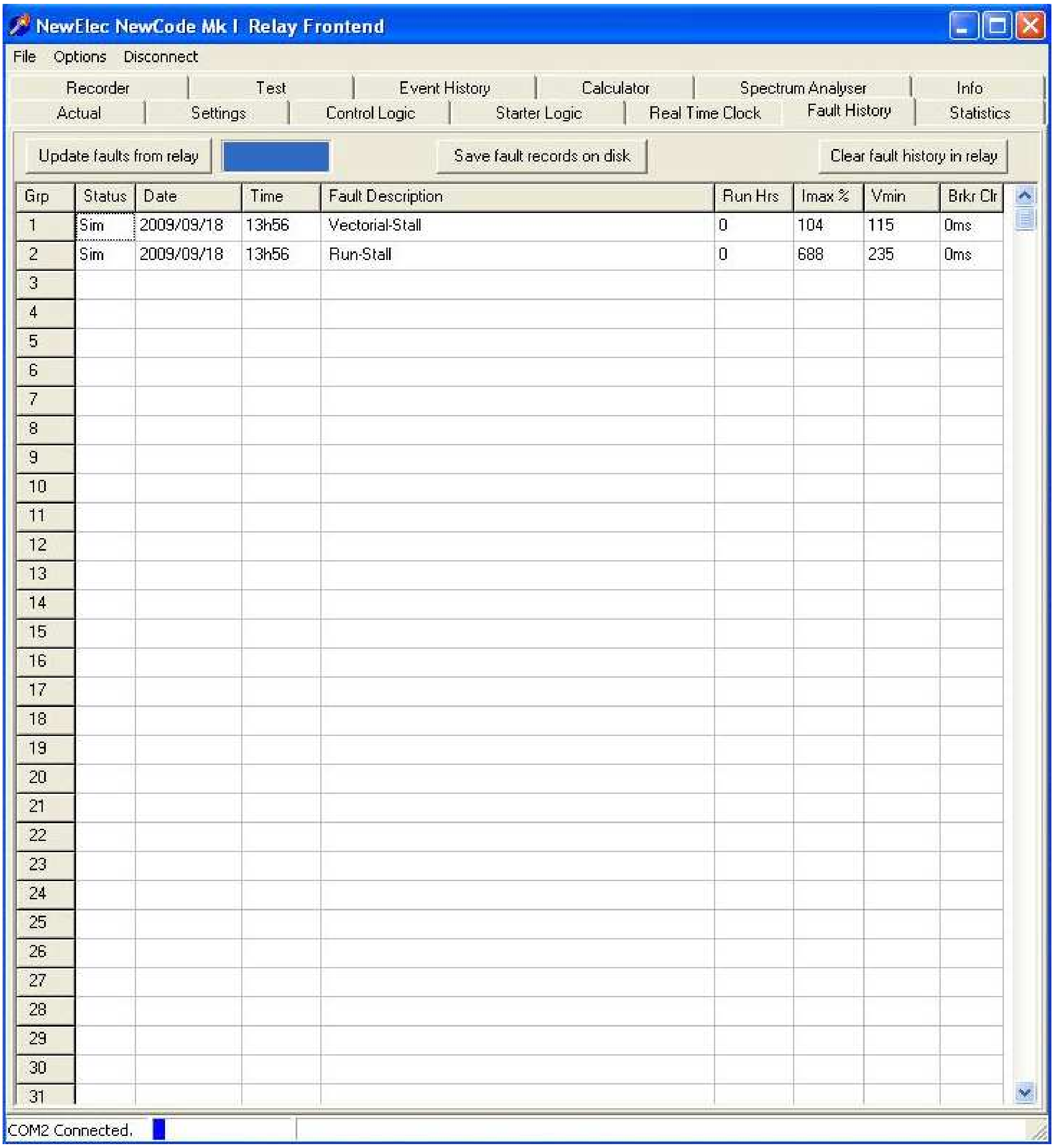
6.4.5 Actual Screen



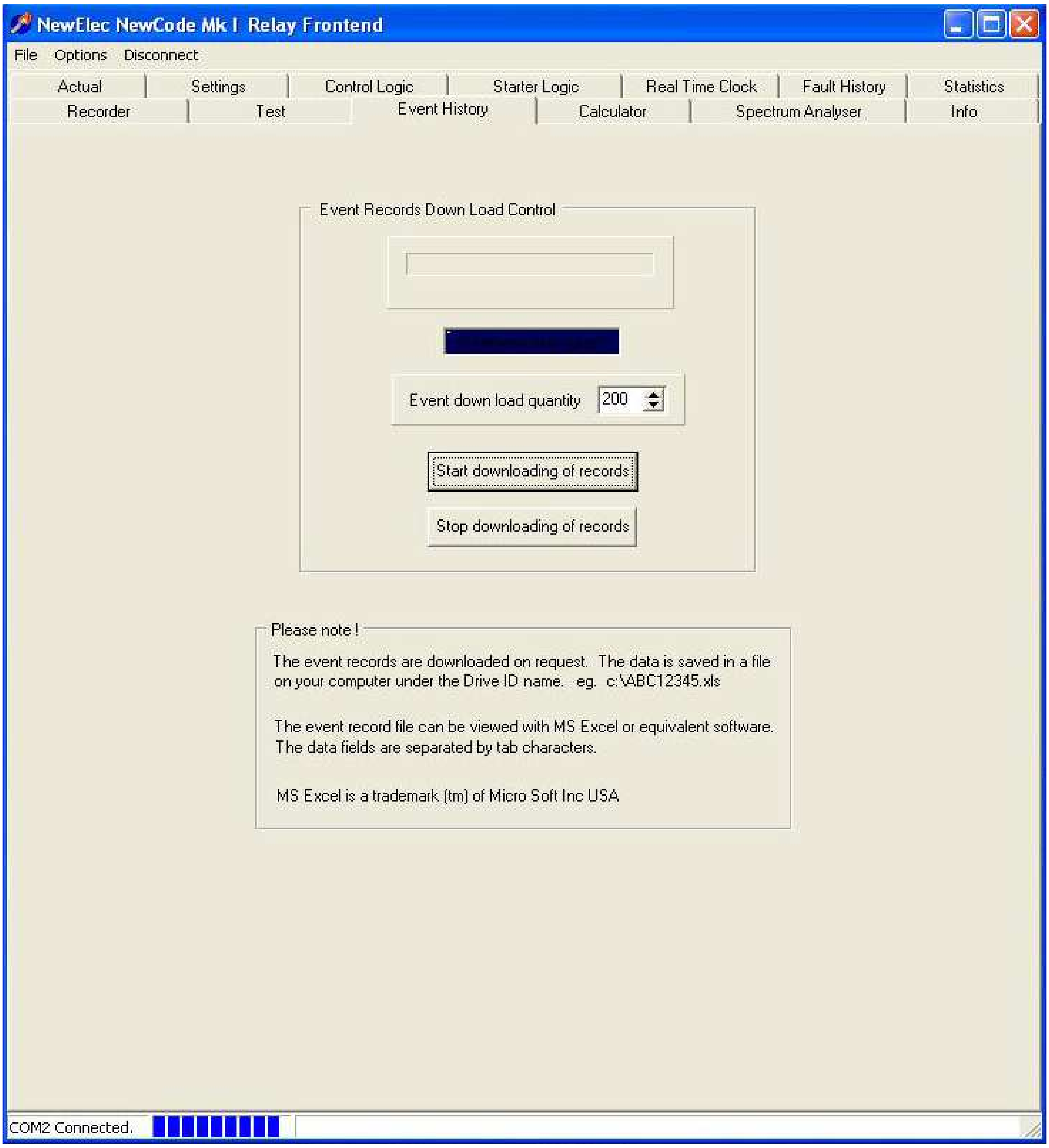
6.4.6 Calculator Screen



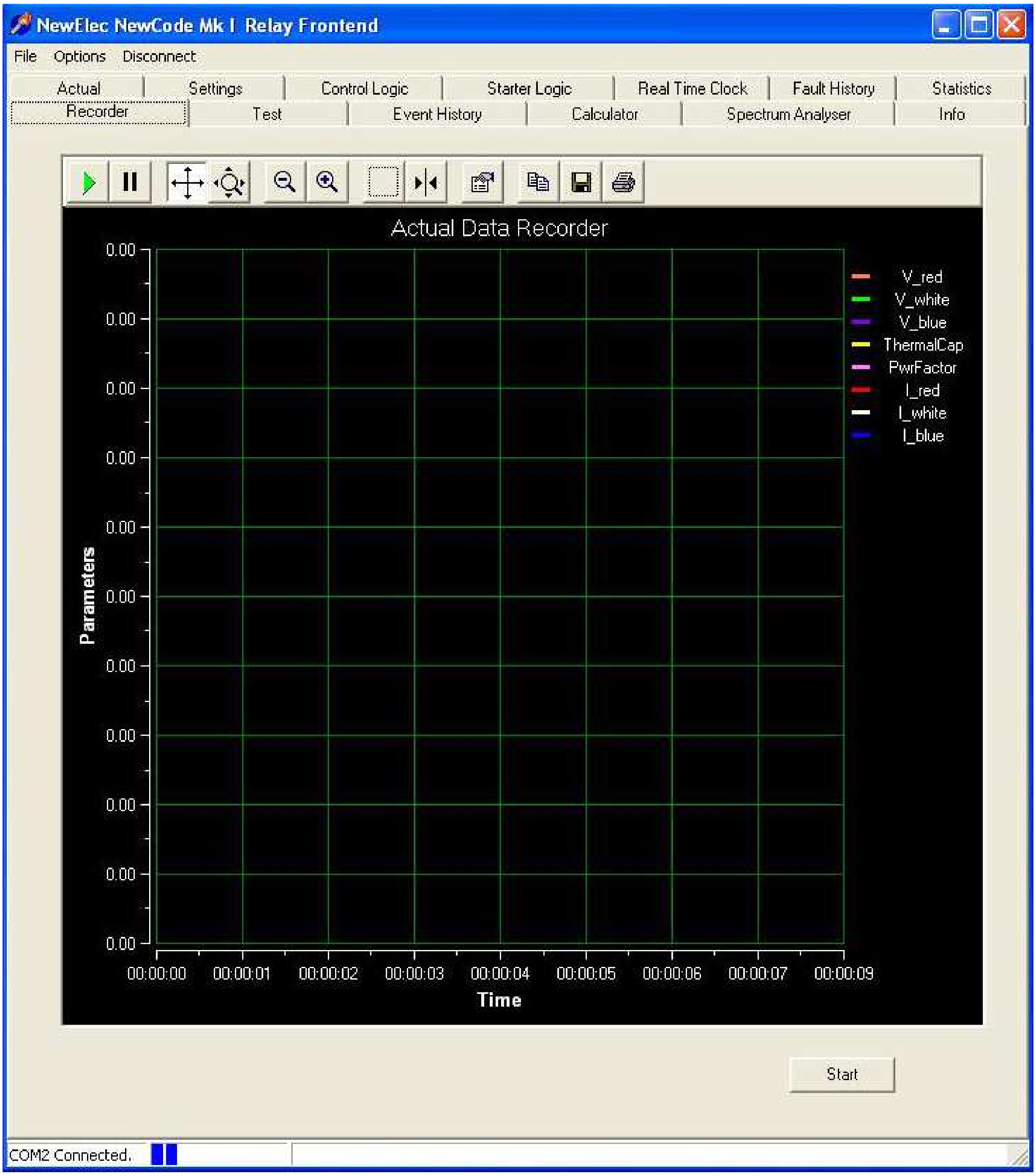
6.4.7 Fault Screen



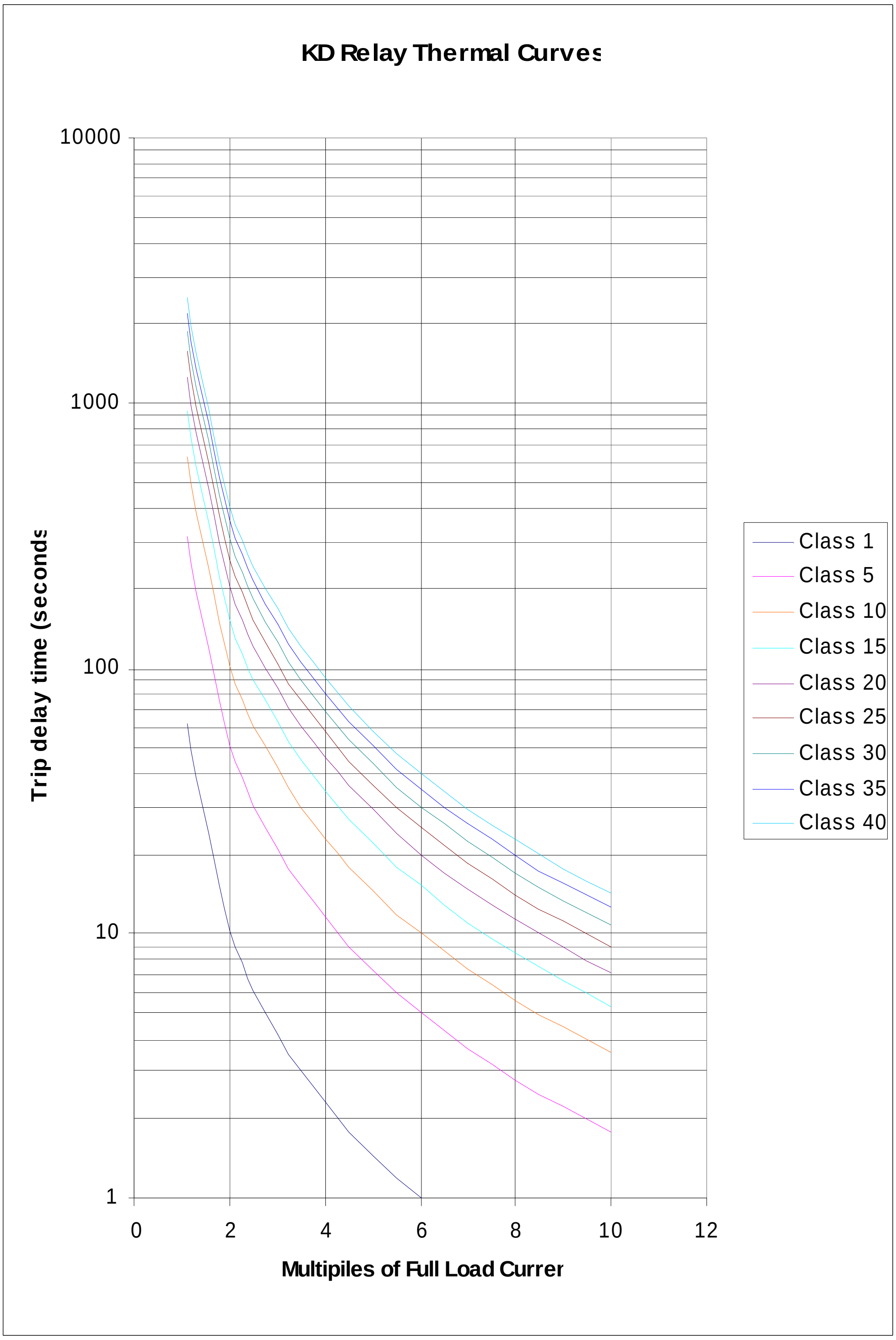
6.4.8 Events Screen



6.4.9 Recorder Screen



6.5 Thermal Curves of the Relay



7. Accessories

7.1 FLED (Part number: KD-I2C-FLED)

It is a field / door mount display unit connected to the relay. This unit relies on power supply from the relay and communicates via the I^2C bus with the relay. The FLED display all the fault conditions similar to the front panel of the relay, thermal capacity used (30% to 100%) and last fault. The FLED has three switches and is allocated as follows:

- Reset switch
- Last fault
- Test switch

The reset switch is similar to the reset switch on the front panel. The last fault switch, when pressed, will replace the current fault indication with the last fault display. When the motor is static and no real current is flowing, the test switch will simulate a phase current injection of 600%. The relay will respond as if it is a true over current condition and calculate thermal capacity usage. An overload trip will result if all the thermal capacity is used.

7.2 IrDA interface (Part number: IRDA-KD)

This an infra red link that can be used in an intrinsic safe environment where isolation is required between the relay and external devices like remote display units (RDU), man-machine interface units (MMI), laptops etcetera.

7.3 Remote Display Unit (RDU) (Part number: KD-RDU-420)

It is a display unit with a 4 x 20 character LCD display and a simplified keyboard. The RDU can perform about 80% of the setup and display functions of the front-end software.

7.4 Man machine interface (MMI) (Part number: KD-MMI-420-EP)

It is similar to the RDU. The unit is packed into a plastic toolbox with battery power supply. The unit is designed for mobility and to be functional in intrinsic safe environments.

--oo0oo--